[as a] substantially in the center between said electrodes [thereof].

## REMARKS

In the Office Action dated August 25, 1993, claims 1-22, all claims pending in the above-identified U.S. patent application were rejected. There is being filed herewith a certified translation of the priority document in this application. Applicants have carefully reviewed the Office Action and submit the amendments above and the remarks to follow as a full and complete response thereto. Reconsideration of the patentability of all of the claims of this application as amended, is solicited.

Claims 1, 3, 5, 7, 8, 11, 15, 16, and 20-22 have been amended in consideration of the examiner's comments in paragraph 15 of the outstanding action and to make them better conform to good United States patent practice. It is submitted that no prohibited new matter has been introduced by these amendments.

The present invention as now claimed is directed to a method for producing semiconductor integrated circuits that comprises a first step of selectively etching a metallic film, disposed on a surface of a substrate where a portion of this film is exposed through a mask, by effectively contacting the exposed areas as of the metal film with a gaseous etchant that comprises chlorine, bromine or a compound thereof; and a second step of, after the etching is completed, removing the mask by ashing it by effectively contacting it with a plasma generated in an atmosphere

containing oxygen gas. The second step may also include removing chlorine, bromine or a compound thereof, which are components of the gaseous etchant, that remain or products resulting therefrom on a surface of the metallic film and which have become exposed as a result of removing (ashing) the mask. The removal of the residual gaseous etchant components includes contacting the metallic film with a plasma, comprising water vapor, to force the gaseous etchant components to be released. In one embodiment of this invention, one plasma, which has been generated in an atmosphere comprising oxygen and water vapor, can be used, to simultaneously accomplish both steps.

In another embodiment, the method comprises: a first step of selectively etching a metallic film exposed through a mask by using a gaseous etchant, that comprises chlorine, bromine or a compound thereof, after the metallic film formed on a surface of a substrate has been selectively covered with a mask made of a resist; a second step of removing the mask used in the etching by ashing, using a first plasma generated in a first atmosphere comprising oxygen gas; and a third step of removing chlorine, bromine or a compound thereof which are components of a residual etchant which has become exposed on a surface of the metallic film as a result of the removal of the mask. The third step, of removing the residual etchant components, includes using a second plasma generated in a second atmosphere containing water vapor. This contact with the second plasma forces the residual etchant components to be released from the surface of the metal film.

The apparatus of the present invention comprises an

etching chamber having means for selectively etching a metallic film formed on a substrate which is partially covered with a mask formed of a resist, an ashing chamber having means for ashing the mask formed on the metal film, and after-treatment chamber including means for removing residual chlorine, bromine or a compound thereof which has become exposed on a surface of the metallic film on the substrate by the removal of the mask. The etching means includes a gaseous etchant that comprises chlorine, bromine or a compound thereof. The ashing chamber is connected to the etching chamber through a first load locked chamber which is capable of holding a vacuum. The ashing means includes a means for generating a first plasma from a first atmosphere comprising oxygen gas. Contact of the first plasma with the mask is under conditions sufficient to ash and thereby remove the mask. The after-treatment chamber is connected to the ashing chamber through a second load lock chamber which is capable of holding a vacuum. The after-treatment means includes a means for generating a second plasma from a second atmosphere comprising water vapor, and means for introducing a gas containing a water vapor into the second plasma generating means.

Claims 3 and 7-13 were rejected under 35 U.S.C. §112, second paragraph for being indefinite. The claims have been amended in consideration of the Examiner's comments. As such, it is submitted that the claims are now free of the further objection. Should the Examiner continue to reject any of these claims on this basis, he is asked to telephone the undersigned attorney with specific proposals for obviating such continuing rejection. Every

consideration will be given to such proposals.

Claims 1-6 were rejected under 35 U.S.C. §103 as being unpatentable over the Japanese Patent Reference No. 63-321198 to Tateiwa in view of the European Patent Application No. 0345757A3 to Shinagawa et al. This combination of references was cited for an alleged showing of all the features of the present invention as claimed.

In contrast to the requirements of claims of this application, the Tateiwa reference merely discloses a method and apparatus for consecutive processes for making the aluminum wiring of semiconductor devices by etching an aluminum film without exposing the aluminum to air in order to protect the resultant wiring from corrosion. In particular, the Tateiwa reference discloses that the residual chlorine deposited on the surface of aluminum during etching, wherein a chlorine compound etchant gas is used, cannot be removed completely during the process of ashing the resist. In order to compensate for the residual chlorine deposition, the Tateiwa reference incorporates a fourth chamber in which the etched aluminum is covered by an insulating film so as to prevent the corrosion of the etched aluminum that would be caused by the chemical reaction between chlorine residue and moisture when the residue is exposed to air. In contrast to this, applicants' claims remove all of the residual chlorine, etc. by contact with a plasma comprising water vapor. This claimed treatment obviates the necessity of inclusion of such a fourth chamber and the corresponding method steps using the fourth chamber. In the reference, the steps preceding the cleaning process in the third

chamber were not effective for the removal of the residual chlorine. In contrast, the treatment of the etched-ashed metal according to this invention is sufficient.

The secondary reference is Shinigawa et al. merely shows the use of oxygen and water for increasing the ashing rate of a resist. However, this reference does not disclose, teach or suggest the use of a plasma comprising water vapor which is effective for removing residual chlorine and decreasing the corrosion of aluminum as is required by the instant claims.

Neither reference provides any disclosure, teaching or suggestion that would motivate their combination such that their combination could embody a process or apparatus similar to those of the present invention. In particular, applicants would contend that neither reference provides any motivation for combining the teaching of using a mixture of oxygen and water for increasing the ashing rate with that of an apparatus and method for cleaning etched aluminum wirings followed by the formation of an insulating film in order to compensate for chlorine residue not fully removed in the prior cleaning steps such that the combination could embody a process or apparatus similar to those claimed herein of removing a mask used in etching by ashing with a plasma generated in an atmosphere comprising oxygen gas and water vapor while at the same time removing chlorine, bromine, or a compound thereof from the surface of the metallic film exposed by the removal of the mask. Rather, the combination of the two references merely show two uncombinable processes which are very different from the present invention, and with none of the features or advantages of the

present invention. As such, applicants would strongly submit that the combination of the Tateiwa and Shinagawa et al. references falls far short of rendering each and every feature of the present invention as claimed obvious to one of ordinary skill in the art.

Claims 11-19 were rejected under 3 U.S.C §103 as being unpatentable over the Fukuyama et al. reference in view of the Shinagawa et al. reference. This combination of references was also cited for an alleged showing of all of the features of the present invention as claimed. First, the priority date of June 27, 1990, of the instant Japanese Priority Application, predates the filing date of August 20, 1990 of the Fukuyama et al. references. As such, applicants would respectively submit that the Fukuyama et al. reference can not be properly cited as a prior art reference against the present invention. In support of this argument, a verified English translation of the instant Japanese Priority Application is filed herewith.

Second, even if the Fukuyama et al. reference was properly citable as prior art against the present invention, this reference merely shows the use of a hydrogen-containing gas for removing chlorine residues, and that water is a well-known hydrogen donating gas. The Fukuyama et al. reference, however, does not disclose, teach or suggest the use of a plasma based on water for removing residual chlorine, etc. from a metallic film, although various other hydrogen component containing gases are cited in combination with the use of a plasma. In particular, the Fukuyama et al. reference merely shows that liquid water is used to dissolve a corrosion component, but the water itself is not used as a part

of a plasma.

Applicants have found that a plasma generated in a water-containing atmosphere is superior for removing chlorine etc. residues on an aluminum surface in comparison with a plasma generated in a hydrogen-containing atmosphere or water vapor without a plasma. Applicants have further found that, in a procedure such as that shown by the Fukuyama et al. reference, corrosion pits will occur on aluminum electrodes which are treated using pure liquid water. In a procedure using the process and apparatus of the present invention, no corrosion was found on the aluminum film which was etched by using a plasma comprising a chlorine, etch. containing gas, which was also exposed to a plasma generated in a water-containing atmosphere. Applicants conclude from such results that the process and apparatus of the present invention are superior and unexpectedly unobvious over those of the Fukuyama et al. reference.

In view of the above comments, applicants strongly contend that neither the Fukuyama et al. reference nor the Shinagawa et al. reference provides any disclosure, teaching or suggestion that would motivate their combination to produce a process or apparatus similar to those of the present invention. In other words, even the combination of the Fukuyama et al. reference with the Shinagawa et al. reference would still fail to disclose, teach or suggest a process or apparatus wherein metallic film partially exposed through a mask is removed by etching using a gas comprising chlorine, bromine or a compound thereof; and after etching, the mask is removed by ashing by contact with a first

plasma generated in a first atmosphere comprising oxygen gas; and chlorine, bromine or a compound thereof which become exposed on the metal surface upon ashing of the mask are removed from the surface of the metallic film using a second plasma generated in a second atmosphere containing water vapor. This second plasma forces the residual etchant components to be released from the metallic film on the substrate.

Claims 20-22 were rejected under 35 U.S.C §103 as being unpatentable over the Tateiwa reference. The Tateiwa reference was cited as alone showing substantially all the features of the present invention as claimed.

Unlike the requirements of the claims of this applications, the Tateiwa reference does not disclose, teach or suggest the use of a plasma comprising water vapor for removing chlorine, etc., nor an apparatus that incorporates an after-treatment chamber having means for introducing a water vapor so as to generate a plasma from the water vapor. As a result, applicants would strongly but respectfully contend that the Tateiwa reference can neither anticipate nor render obvious each and every feature of the present invention as claimed in claims 20-22.

Consequently, as discussed above, certain clear and distinct differences exist between the present invention as now claimed and the prior art references upon which the rejections rely. These differences are more than sufficient to show that the present invention would not have been anticipated nor rendered obvious given the prior art cited. Rather, applicants would respectfully contend that the present invention as now claimed is

distinguished over the prior art and the claims of this application are therefore allowable.

In the event that this paper is not timely filed, applicants hereby petition for an appropriate extension of time. The fee for any such extension may be charged to Deposit Account No. 14-1060, along with any other fees due or additional fees which may be required with respect to filing of this paper.

Respectfully submitted,

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Enclosure: Certified translation of the priority document